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ABSTRACT

This trade and industrial curriculum guide is intended for use in vocational programs that prepare students to enter the air conditioning/refrigeration field. The introductory section provides a statement of philosophy, objectives, block time schedule, and recommended facilities and equipment. Following the introductory section, eighteen blocks of instruction are presented: (1) Orientation: (2) Refrigeration Tools: (3) Copper Tubing and Fittings: (4) Electricity: (5) Air Conditioning and Refrigeration Fundamentals: (6) Compression Systems: (7) Compressors: (8) Evaporators, Condensers, Receivers, and Other Components: (9) Refrigerants: (10) Refrigerant Controls: (11) Domestic Hermetic Refrigerators and Freezers: (12) Window Air Conditioning Units and Residential Air Conditioning Systems: (13) Commercial Air Conditioning Systems: (14) Commercial System Controls: (15) Absorption: (16) Automobile Air Conditioning: (17) Heat Pumps: and (18) Heating Systems. Each block provides a table that lists the units of instruction, informational content of each unit, and skill development activities. In addition, a list of instructional aids is provided for each block. Appended material includes a unit guide example, a list of safety precautions, suggestions for shop management, and additional references. (LRA)

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V&TECC CURRICULUM GUIDE

Vocational and Technical Education Curriculum Center

INSTRUCTIONAL GUIDE FOR AIR CONDITIONING AND REFRIGERATION

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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Division of Vocational and Technical Education
College of Education
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Blacksburg, Virginia 24061

and

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FOREWORD

This is another in a series of Trade and Industrial Curriculum guides. It is intended that this Air Conditioning and Refrigeration Curriculum Guide be used with vocational programs which prepare students to enter the Air Conditioning/Refrigeration field.

We have purposely eliminated the binding of these guides so that they may be punched and placed in notebooks, thus making it possible to remove and replace material as needed.

Thanks are expressed to all the instructors listed on the following page and to Dr. Lester G. Duenk who coordinated the development of this guide.

We anticipate that you will find it useful to supplement the guide with appropriate lesson plans and instruction sheets.

Ben L. Baines
State Supervisor
Trade & Industrial Education
Virginia Department of Education
Richmond, Virginia 23216

September 1979

PREFACE

This curriculum guide was developed to serve as a state-wide model for Virginia vocational air conditioning and refrigeration programs. The instructor may utilize this curriculum guide in a manner deemed most advantageous to the local situation.

This guide is designed for 960 hours of air conditioning and refrigeration instruction and was developed by a group of Virginia vocational air conditioning and refrigeration instructors in a workshop held at Virginia Polytechnic Institute and State University.

The instructors participating in the development of this guide were as follows:

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PHILOSOPHY

We believe that the air conditioning and refrigeration program will provide students with the technical and manipulative skills necessary to become self-sufficient, develop self confidence, be thorough and precise in their work habits, and become skilled craftspersons capable of performing the tasks of the trade with pride.

Student will be motivated to higher levels of achievement, gain respect for outstanding craftspersons in the field and develop attitudes which are essential to good citizenship.

We also believe this training will encourage a determination within students to acquire a job, and in turn, become a productive member of society.

OBJECTIVES

The overall purpose of this curriculum is to prepare the student for entry-level positions in industry by fulfilling the following objectives:

1. To develop an understanding of the air conditioning and refrigeration trade; encourage safe work habits; and provide a skill sufficient to acquire employment;

2. To gain knowledge and skills of the techniques involved in environmental air conditioning, which includes cooling and heating;

3. To acquire a knowledge of the techniques involved in refrigeration;

4. To acquire a knowledge of all aspects of air distribution;

5. To acquire the necessary skills that are required to troubleshoot the electrical systems found in air conditioning and refrigeration units;

6. To understand related math, layout, measurements, blueprint-reading and assembly, which pertain to air conditioning and refrigeration;

7. To develop proper work habits, attitudes, and the desire to obtain and hold a job;

8. To develop an appreciation for habitual cleanliness, neatness, and orderliness in work and personal life;

9. To create self-confidence through acquired knowledge and skill development; and,

10. To develop those qualities which develop responsible citizenship and foster professional ethics.

Related instruction will be given by lecture, demonstration, and the presentation of audio-visual materials immediately prior to and during application by the trainee.

Approximately 60 to 75% of the allocated time will be spent in manipulative skill development.

BLOCK TIME SCHEDULE (Suggested)

Block	Title	Recommended Hours
1	Orientation	15
2	Refrigeration Tools	15
3	Copper Tubing and Fittings	40
4	Electricity	40
5	Air Conditioning and Refrigeration Fundamentals	55
6	Compression Systems	40
7	Compressors	55
8	Evaporators, Condensers, Receivers and other Components	45
9	Refrigerants	15
10	Refrigerant Controls	50
11	Domestic Hermetic Refrigerators and Freezers	90
12	Window A/C Units and Residential A/C Systems	90
13	Commercial Systems	85
14	Commercial System Controls	40
15	Absorption Systems	25
16	Automobile Air Conditioning	70
17	Heat Pumps	40
18	Heating Systems	150
		960

RECOMMENDED FACILITIES AND EQUIPMENT

I. The school shop should be designed:

1. To meet the objectives of the educational program;
2. For the comfort of the students and teachers;
3. For economy of operation;
4. For convenience of instruction;
5. For flexibility of offerings;
6. For future extension;
7. For best possible space utilization;
8. For ease of administration and supervision;
9. For safety of the building and of the students and teacher using it; and,
10. To obtain maximum values for the funds expended.

II. Recommendations for the shop layout:

1. A shop for twenty students should include a minimum of 4000 square feet of floor space;
2. Two hundred square feet should be allowed for tool storage;
3. Two hundred fifty square feet should be allowed for equipment, materials and project storage;
4. Six hundred square feet should be allowed for classroom space;
5. Sufficient electrical outlets providing the following voltage and current ratings:

   a. 110 and 220 VAC, single phase and three phase
   b. 20, 30 and 60 amp sources
   c. 600 amp service within the shop

6. Suggested facilities:

   a. Locker rooms for male and female students
   b. Storage for individual tool boxes

III. Major equipment list:

1.	Air compressor and accessories	(1)
2.	Pedestal 15" drillpress 1/2" chuck	(1)
3.	Pedestal 6" to 8" guides with wire wheel	(2)
4.	4" bench vice with pipe jaws	(4)
5.	Vacuum pump (high)	(1)
6.	Vacuum pump 0" - 29"	(2)
7.	Manifold sets	(20)
8.	Parts cleaner	(1)
9.	1/4 ton condensing units, air cooled, belt driven	(5)
	1/4 ton condensing units, water cooled	(1)
	1/4 ton condensing units, air cooled, semi-hermetic	(5)
10.	Open type compressors	(4)
11.	Evaporators	(11)
12.	Changing stations	(1)
13.	Hermetic system analyzer	(1)
14.	Charging cylinders dial-a-charge	(1)
15.	Thermometers (test)	(8)
16.	Recording thermometer (two temp.)	(1)
17.	Volt-watt meter	(6)
18.	Amprobe 0-300 amps	(6)
19.	Simpson 260S VOM	(6)
20.	CO_2 indicator kit	(2)
21.	Oil tired furnace	
22.	Electronic leak detector	(1)
23.	Halide leak detector	(6)
24.	Motor starting cords 115 & 230V	(6)
25.	Presto-lite torch kits	(8)
26.	Capillary tube cleaner (hydraulic)	(1)
27.	Capacitor checker	(2)
28.	Refrigeration trainer board	(1)
29.	Heating and air conditioning electrical control board	(1)
30.	Electric heat trainer	(1)
31.	Bi-metal trainer	(1)
32.	Cadmium cell	(1)
33.	Heat pump	(1)
34.	Two ton compressor trainer	(1)
35.	Work benches and stools for students	(20)
36.	Air velocity meter	(1)
37.	Sling psychrometer	(6)
38.	Demonstration tables	(1)
39.	Tuning devices	(2)
40.	Rubber mats	(20)
41.	Assortment of electrical and refrigeration Controls for demonstration purposes	--
42.	Gas fired upright furnaces	(1)
43.	Central a/c unit for above	(1)
44.	Electric cord reels	(4)
45.	Fuel pump test kit (oil)	(1)
46.	Hot water demonstration unit	(1)
47.	Auto air conditioning demonstrator unit	(1)
48.	Appliance hand truck or dolly	(1)

IV. Hand tools:

Tool boards
Hammers - ball peen assortment
Hammers - plastic tip assortment
Hammers - rubber assortment
Hammers - brass assortment
Hammers - claw assortment
Hammers - rawhide assortment
Hammers - cross peen assortment
Mallets - wood, rawhide, lead, rubber

Tool boards
Screwdrivers - regular tip assortment
Screwdrivers - phillips assortment
Screwdrivers - offset assortment
Screwdrivers - ratchet assortment
Screwdrivers - clutch head assortment

Tool boards
Wrenches - open end assortment
Wrenches - box end assortment
Wrenches - combination open and box end assortment
Wrenches - flare nut assortment
Wrenches - adjustable jaw assortment
Wrenches - pipe assortment
Wrenches - strap
Wrenches - 1/4" drive - sockets shallow and deep well
Wrenches - 3/8" drive-sockets shallow and deep well
Wrenches - 1/2" drive-sockets shallow and deep well
Ratchets - 1/2" drive
Ratchets - 3/8" drive
Extension bars for sockets 1/4" - 3/8" - 1/2" drive assortment
Flex handles for sockets 1/2" - 3/8" - 1/2" drive assortment
Torque wrench - inch pounds
Nut-cutters
Torque wrench - foot pounds
Stud extractors
Wrench - inside pipe
Wrench - allen assortment
Wrench - flex socket assortment
Chisels - assortment
Punches - assortment
Gear and pully pullers - assortment
Pliers - common slip joint
Pliers - hose clamp
Pliers - channel lock
Pliers - needle nose
Pliers - diagonal cutters
Pliers - vise grip

IV. Hand tools: (continued)

Pliers - electrician (insulated)
Strippers - wire
Files - flat assortment with handles
Files - round assortment with handles
Files - three corner assortment with handles
Knives - putty assortment
Scrapes - gaskets assortment
Brushes - steel assortment
Brushes - brass assortment
Brushes - bristle assortment
Magnetic pickup assortment
Telescoping mirror
Hack saws - assortment
Twist drills - assortment
Taps and dies - assortment
Pipe taps - assortment
Reamers - inside and outside assortment
Pipe cutters
Metal shears - assortment
Tubing cutters
Flaring tools
Tubing bender - assorted sizes
Shop air compressor
Shop air hoses
Air blow guns (safety type)
Parts cleaner (motor driver)
Soldering gun
Soldering irons - assorted sizes
Welding equipment (gas)
Complete set of repair and service tools for auto A/C
Vacuum pump
Charging manifold sets
Dial-a-charge
Vises - pipe
Vises - brick
Propane gas torch kits
Acetylene torch bits
Thermometer - service assortment
Micrometer - assorted sizes
Feeler gauges - assorted sizes
Drop lights
Adjustable end wrenches 8"
Adjustable end wrenches 12"

Think metric. Select an assortment of measuring devices and one metric tool set in preparation for their introductions and use in the near future.

Block 1 TITLE ORIENTATION Hours 15

Units of Instruction	Information/Methodology	Skill-Development Activities
A. School Policy	Distribute copies of school manual. Lecture: Explain school policy.	Read materials and discuss.
B. Shop and School Orientation	Conduct a guided tour of the school.	Observe and become familiar with different areas of the school.
C. General Shop Safety Rules	Explain safety rules and procedures. Distribute relevant literature.	Read literature and demonstrate understanding of safety rules and procedures.
D. Occupational Information	Discuss occupational information and distribute any pertinent literature.	Read and discuss.
E. Issue Books, Lockers, Coveralls, Hard Hats, Safety Glasses, Etc.	Explain policy relative to student use and responsibility for issued materials.	Receive and store materials in proper places.
F. Collect All Fees	Explain purpose of the fees.	Pay fees.
G. Filling Out Data Sheets		Fill out forms.
H. Introduction To VICA	Discuss the VICA program.	Discussion.

INSTRUCTIONAL AIDS

FOR

BLOCK 1

1. Pamphlets on school policy.

2. Film strip on safety.

3. Material on VICA.

4. The following film strips may be obtained from the Bureau of Teaching Materials, Virginia Department of Education, Richmond, VA. 23216.

Safety in the Shop - Basic Practices	#37310
Safety with Fire	#46305
Safety with Electricity	#67905

Block 2 TITLE REFRIGERATION TOOLS Hours 15

Units of Instruction	Information/Methodology	Skill-Development Activities
A. Hand Tools 1. Identification 2. Proper use and care	Lecture and demonstration.	Demonstration by students.
B. Power Tools 1. Safety 2. Proper use and care	Explain how to use and care for power tools safely.	Check that all tools are properly grounded.
C. Testing and Measuring Instruments	Lecture and demonstration.	Demonstrate proper use and care.
D. Special Instruments	See tool list.	

INSTRUCTIONAL AIDS

FOR

BLOCK 2

1. Books:

Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning. Goodheart and Willcox Company, 18250 Harwood Avenue, Homewood, Illinois 60430.

2. Equipment and Materials:

Assortment of hand tools
Electric drills
Power saws
Electric grinders
VOM
Amprobe

Block 3 TITLE COPPER TUBING AND FITTINGS Hours 40

Units of Instruction	Information/Methodology	Skill-Development Activities
A. Sizing and Layout	Lecture and demonstration.	Students will select tubing and match fitting sizes for project layout.
B. Flare, Swage and Bending	Lecture on correct procedure.	Students will flare, swage, and bend properly, all sizes of copper tubing.
C. Soldering 1. Soft 2. Hard	Discuss proper ventilation, work area, and tempering.	Students will solder copper to copper, using different types of soft and hard solder.
D. Annealing	Lecture and demonstration.	
E. Trouble Shooting (leak testing)	Explain and demonstrate how to test tubing for leaks.	Students will pressure test soldered connections for leaks.

INSTRUCTIONAL AIDS

FOR

BLOCK 3

1. Books:

Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning. Goodheart and Willcox Company, 18250 Harwood Avenue, Homewood, Illinois 60430.

2. Equipment and Materials:

Assorted sizes of copper tubing
Fittings
Flaring tools
Swaging tools
Bending tools
Solder
Cleaning brushes
Sand cloth
Safety equipment

3. Visual Aids:

Film strip

Block 4 TITLE ELECTRICITY Hours 40

Units of Instruction	Information/Methodology	Skill-Development Activities
A. Basic Concepts	Lecture and demonstrate. Safety. Sources of electricity. a. Friction b. Magnetism c. Chemical d. Pressure e. Heat f. Light	Take notes. Engage in discussions. Perform lab experiments. a. Magnets b. Batteries c. Phonograph d. Thermistor e. Photo cell
B. Electron Theory	Flow of electrons.	Use handouts.
C. Magnetism	Types of magnets. Polarity of poles. Lines of force.	Make magnetic display board. Use handouts.
D. Classes of Materials and Uses	Conductors Insulators Semiconductors A.W.G. Sizing	Use handout. Use the following: a. Ohmmeters b. Wire Gauges c. Charts
E. Capacitance, Inductance and Uses	Capacitors Inductors	Disassemble, test and check coils and transformers.

Block 4 TITLE ELECTRICITY (Continued) Hours 40

Units of Instruction	Information/Methodology	Skill-Development Activities
F. Circuits and Laws of Electricity	Basic components of a circuit a. Power Supply b. Current Path c. Resistance or Load	Use display board. Use following voltage sources: a. Battery b. A.C. Line Voltage c. Megohmmeter
	Sources of E.M.F. Types of circuits: a. Series b. Parallel	Use A.C. to D.C. controls. Use wattmeter and ammeter. Build: series circuit, parallel circuit and combination circuit. Use PIRE and other charts.
	Laws a. Ohm's Law b. Kirchhoff's Law	
G. Electromagnets	Discuss and demonstrate types of magnets.	Energize and troubleshoot.
H. Test Instruments	Types of meters: a. VOM b. Amprobe c. Wattmeter d. Megohmmeter e. Hermetic Analyzer f. Other	Demonstrate care, caution, and safety in operation of instruments. Use instruments and record readings.

Block 4 TITLE ELECTRICITY (Continued) Hours 40

Units of Instruction	Information/Methodology	Skill-Development Activities
I. Transformers	Discuss transformer construction, operation, and terminology.	Connect transformer. Understand voltage and uses of delta and wye connections.
J. Motors	Discuss types of motors. a. Repulsion - start induction type b. Capacitor - start induction type c. Induction - polyphase type d. Induction - two phase e. Shaded - pole type f. Capacitor type	Identify types of motors. Troubleshoot motors. Install bearings. Install centrifugal switch. Make ohmmeter tests. Install and read capacitor.
K. Relays, Contactors, Starters, and Circuit Protectors	Types a. Relay b. Starters c. Circuit protectors	Identify, test and install relays used in air conditiong and refrigeration. Repair - change starters, contactors, breakers.
L. Controls	Types a. Electrical b. Pneumatic c. Electronic d. Other	Test, replace or adjust different types of controls.
M. Wire Splicing	Lecture - demonstration and discussion.	Identify and use different splices.

Block 4 TITLE ELECTRICITY (Continued) Hours 40

Units of Instruction	Information/Methodology	Skill-Development Activities
N. Types of Splices 1. Western Union 2. Pig Tail 3. T-Splice		Make the three splices.
O. Types of Wire Connections 1. Wire Nut 2. Lugs 3. Crimp 4. Soldering	Lecture - demonstration and discussion	Identify and use: a. Wire nut b. Lugs c. Crimping tool Solder the three types of splices.
P. Troubleshooting	Explain and demonstrate troubleshooting of various components.	Identify components. Choose correct instrument and test components. Make continuity tests.

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INSTRUCTIONAL AIDS

FOR

BLOCK 4

1. Books:

Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning. Goodheart and Willcox Company, 18250 Harwood Avenue, Homewood, Illinois 60430.
Chapters 7, 8, 23.

2. Visual Aids:

Wall charts
Transparencies
Slides
Films

Block 5 TITLE AIR CONDITIONING AND REFRIGERATION FUNDAMENTALS Hours 55

Units of Instruction	Information/Methodology	Skill-Development Activities
A. Introduction 1. Development of Refrigeration 2. Principles of Operation 3. Basic Terms	Lecture and discussion. Safety.	Students will develop a safety consciousness that will be demonstrated when working with equipment.
B. Basic Theory of Refrigeration 1. Heat Transfer a. Radiation b. Conduction c. Convection 2. Laws a. Boyle's b. Charles' c. Dalton's	Lecture and discussion.	Students will use student trainers to demonstrate theories and principles covered in classroom activities.
C. Temperature and Pressure	Lecture and discussion.	
D. Humidity		
E. Expansion and Contraction	Lecture and discussion.	

INSTRUCTIONAL AIDS

FOR

BLOCK 5

1. Books:

Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning. Goodheart and Willcox Company, 18250 Harwood Avenue, Homewood, Illinois 60430.
Chapter 1.

2. Equipment and Materials:

Student trainers

3. Visual Aids:

Films
Charts

Block 6 TITLE COMPRESSION SYSTEMS Hours 40

Units of Instruction	Information/Methodology	Skill-Development Activities
A. Introduction	Lecture and demonstration using textbook and charts.	Students will become familiar with compression cycle components by handling.
B. Laws of Refrigeration		
C. Compression Cycle		
D. Identification of Components 1. Compressor 2. Condenser 3. Evaporator 4. Metering devices 5. Refrigerant lines 6. Liquid receiver 7. Drives and sight glasses 8. Electric motors 9. Electric motor controls	Lecture and demonstration.	Students will place components in a simulated cycle. Students will trace refrigerant flow through simulated cycle or trainer cycle.

INSTRUCTIONAL AIDS

FOR

BLOCK 6

1. Books:

Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning. Goodheart and Willcox Company, 18250 Harwood Avenue, Homewood, Illinois 60430.

General Motors Booklet. A to Zero of Refrigeration.

2. Visual Aids:

Films
Charts

Block 7 TITLE COMPRESSORS Hours 55

Units of Instruction	Information/Methodology	Skill-Development Activities
A. Reciprocating 1. Principle of operation 2. Construction	Lecture, discussion and demonstration.	Students will disassemble compressors, study all parts and reassemble.
B. Rotary 1. Principle of operation 2. Construction	Lecture, discussion and demonstration.	Students will locate positions C.S.R. on motors, connect wattmeter and motor start cord.
C. Scotch-Yoke 1. Principle of operation 2. Construction	Lecture, discussion and demonstration.	
D. Swash-Plate (Wobble Plate) 1. Principle of operation	Lecture, discussion and demonstration.	
E. Centrifugal 1. Principle of operation 2. Construction	Lecture, discussion and demonstration	
F. Other		

INSTRUCTIONAL AIDS

FOR

BLOCK 7

1. Books:

Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning. Goodheart and Willcox Company, 18250 Harwood Avenue, Homewood, Illinois 60430.
Chapter 5.

2. Visual Aids:

Films
Charts

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Block 8 TITLE EVAPORATORS, CONDENSERS, RECEIVERS AND OTHER COMPONENTS Hours 45

Units of Instruction	Information/Methodology	Skill-Development Activities
A. Evaporators 1. Bare tube 2. Plate surface 3. Finned	Discuss safety. Lecture, demonstration and discussion.	Students will perform lab projects and make epoxy repair.
B. Condensers 1. Indoor remote 2. Air cooled 3. Water cooled		Students will perform lab projects and make epoxy repair.
C. Liquid Receivers 1. Horizontal 2. Vertical		Students will perform lab projects and make epoxy repair.
D. Other Components 1. Discharge lines 2. Receive lines 3. Liquid lines 4. Sight glass 5. Mufflers		Students will perform lab projects and make epoxy repair.

INSTRUCTIONAL AIDS

FOR

BLOCK 8

1. Books:

Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning. Goodheart and Willcox Company, 18250 Harwood Avenue, Homewood, Illinois 60430.
Chapter 13.

2. Visual Aids:

Films
Charts

Block 9 TITLE REFRIGERANTS Hours 15

Units of Instruction	Information/Methodology	Skill-Development Activities
A. Introduction B. Safety When Handling Refrigerants	Lecture, demonstration and discussion.	Students will learn how to safely handle refrigerants. They will learn the requirements of refrigerants, the different types of refrigerants and their pressures.
C. Requirements for Refrigerants 1. Should be non-poisonous 2. Should be non-explosive 3. Should be non-corrosive 4. Other	Lecture.	
D. Identification of Refrigerants	Lecture and demonstration.	Students will learn the classification and application of refrigerants.
E. Classification of Refrigerants 1. Group one 2. Group two		

Block 9 TITLE REFRIGERANTS (Continued) Hours 15

Units of Instruction	Information/Methodology	Skill-Development Activities
F. Refrigerant Cylinder Color Code	Lecture and demonstration.	Students will learn the operating pressure of different refrigerants and be able to convert pressure to temperature.
G. Selection of Refrigerant		
H. Replacing Refrigerant		
I. Pressure and Temperature Conversions	Lecture and demonstration.	

INSTRUCTIONAL AIDS

FOR

BLOCK 9

1. Books:

Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning. Goodheart and Willcox Company, 18250 Harwood Avenue, Homewood, Illinois 60430.

2. Visual Aids:

Free literature from refrigerant producing companies
Pressure, temperature conversion charts
Films

Block 10 TITLE REFRIGERANT CONTROLS Hours 50

Units of Instruction	Information/Methodology	Skill-Development Activities
A. Introduction	Lecture, demonstration and discussion.	Students will identify and learn the correct use of all refrigerant controls.
B. Classes of Controls 1. Controls based on pressure changes 2. Controls based on temperature changes 3. Controls based on volume or quantity changes		Students will trouble shoot control problems.
C. Capillary Tubes	Lecture, demonstration and discussion.	
D. Thermostatic Expansion Valves		
E. Automatic Expansion Valves		
F. Check Valves		
G. Pressure Regulating Valves	Lecture, demonstration and discussion	
H. Solenoid Valves		
I. High and Low Side Floats		

INSTRUCTIONAL AIDS

FOR

BLOCK 10

1. Books:

Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning. Goodheart and Willcox Company, 18250 Harwood Avenue, Homewood, Illinois 60430.
Chapter 6.

2. Visual Aids:

Student Trainers
Films
Charts

Block 11 TITLE DOMESTIC HERMETIC REFRIGERATORS AND FREEZERS Hours 90

Units of Instruction	Information/Methodology	Skill-Development Activities
A. Development	Lecture and discussion.	
B. Safety		
C. Basic Refrigeration Cycles	Lecture and demonstration.	Students will identify two methods of temperature control.
D. Cabinets and Seals		
E. Electrical Circuits	Lecture and demonstration.	Students will disassemble and reassemble a refrigerator.
F. System Charging	Lecture and demonstration.	Student will read schematics, be able to identify and install all controls.
G. Trouble Shooting	Lecture and demonstration.	Charge and balance system. Trouble shoot and repair defective units.

INSTRUCTIONAL AIDS

FOR

BLOCK 11

1. Books:

Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning. Goodheart and Willcox Company, 18250 Harwood Avenue, Homewood, Illinois 60430.
Chapter 10.

2. Visual Aids:

Charts

Block 12 TITLE WINDOW A/C UNITS AND RESIDENTIAL A/C SYSTEMS Hours 90

Units of Instruction	Information/Methodology	Skill-Development Activities
A. Safety	Lecture.	Students will demonstrate safe handling of window units.
B. Window Units 1. Types of Mounts a. Wall b. Window	Lecture and demonstration.	Lab experiments performed by students will demonstrate principles of operation and methods of installation.
2. Components a. Evaporator Coil b. Condenser c. Motor - Compressor d. Filter e. Drier f. Fan Motor	Lecture, demonstration and discussion.	
3. Installation a. Sealing b. Braces c. Drainage d. Wiring	Lecture, demonstration and discussion.	Students will be able to install and service window units.
4. Servicing a. Annual cleaning b. Lubrication c. Trouble shooting		

Block 12 TITLE WINDOW A/C UNITS AND RESIDENTIAL A/C SYSTEMS (Continued) Hours 90

Units of Instruction	Information/Methodology	Skill-Development Activities
C. Residential Units 1. Evaporator Coils a. A-Type b. Horizontal c. Slant	Lecture, demonstration and discussion.	Students will demonstrate principles and practices through the performance of lab experiments.
2. Condensing Units a. Wall Type b. Through the wall type c. Concrete Slab Mounted	Lecture, demonstration and discussion.	
3. Installation a. Condenser b. Evaporator c. Suction and Liquid Lines d. Wiring	Lecture, demonstration and discussion.	
4. Equipment a. Pre-Charged Tubing b. Condensate Drain c. Quick-Connect Couplings d. Other	Lecture, demonstration and discussion.	

Block 12 TITLE WINDOW A/C UNITS AND RESIDENTIAL A/C SYSTEMS (Continued) Hours 90

Units of Instruction	Information/Methodology	Skill-Development Activities
C. Residential Units (Continued) 5. Servicing a. Annual Cleaning b. Lubrication c. Troubleshooting	Lecture and demonstration.	Students will demonstrate ability to service units. Related lab experiements will be performed.

INSTRUCTIONAL AIDS

FOR

BLOCK 12

1. Books:

Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning. Goodheart and Willcox Company, 18250 Harwood Avenue, Homewood, Illinois 60430.
Chapter 21.

2. Audio and/or Visual Aids:

Films
Charts

3. Residential Air Conditioning Unit

Block 13 TITLE COMMERCIAL SYSTEMS Hours 85

Units of Instruction	Information/Methodology	Skill-Development Activities
A. Introduction	Lecture.	Students will determine heat load and size refrigeration unit for a walk-in room.
B. Safety		
C. Heat Loads and Unit Sizing 1. Wall heat transmission load 2. Air change load 3. Product load 4. Miscellaneous load	Lecture, demonstration and discussion.	Students will determine commercial temperatures.
D. Piping Layouts	Lecture, demonstration and discussion.	Students will construct a piping layout.
E. Air Distribution	Lecture, demonstration and discussion.	Students will learn to properly locate cooling coils, and air-cooled condensing unit for most efficient and effective air distribution.
F. Multi-Stage Systems		Students will learn the requirements of a multi-stage system. Students will learn the correct application of multi-stage systems.

Block 13 TITLE COMMERCIAL SYSTEMS (Continued) Hours 85

Units of Instruction	Information/Methodology	Skill-Development Activities
G. Heating and Humidifying	Lecture, demonstration and discussion.	Students will demonstrate with equipment and instruments, the advantages of humidifying with heating and dehumidifying with cooling.
H. Cooling and Dehumidifying	Lecture, demonstration and discussion.	
I. Air Distribution and Cleaning	Lecture, demonstration and ciscussion.	
J. Controls and Instruments	Lecture, demonstration and discussion.	Students will demonstrate with instruments, that proper duct, grille, and register sizing and location are necessary for best air distribution.

INSTRUCTIONAL AIDS

FOR

BLOCK 13

1. Books:

Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning. Goodheart and Willcox Company, 18250 Harwood Avenue, Homewood, Illinois 60430.
Chapter 16.

2. Equipment:

Warm air furnace (oil or gas)
Air conditioning unit
Air filters
Humidifier
Air measuring instruments

3. Visual Aids:

Charts
Films

4. Heat Load Calculation Forms

Block 14 TITLE COMMERCIAL SYSTEM CONTROLS Hours 40

Units of Insturction	Information/Methodology	Skill-Development Activities
A. Introduction	Lecture and discussion.	Students will identify and know the uses of commercial system controls.
B. Safety		
C. Pressure and Temperature	Lecture and demonstration.	
D. Time Clocks		
E. Solenoid Valve		
F. Ice Maker Control	Lecture and demonstration.	
G. Two-Temperature Control		
H. Oil Separators and Accumulators	Lecture and demonstration.	
I. Other		

INSTRUCTIONAL AIDS

FOR

BLOCK 14

1. Books:

Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning. Goodheart and Willcox Company, 18250 Harwood Avenue, Homewood, Illinois 60430.
Chapters 13, 14, 15, 23.

2. Visual Aids:

Charts
Films

70

Block 15 TITLE ABSORPTION SYSTEMS Hours 25

Units of Instruction	Information/Methodology	Skill-Development Activities
A. Introduction	Lecture and discussion.	Students will learn the principles of operation of absorption systems.
B. Safety		
C. Principles of Operation	Lecture and demonstration.	
D. Types of Systems 1. Solid Absorbing 2. Liquid Absorbing		
E. Classification of Systems 1. Intermittent 2. Continuous	Lecture and demonstration.	
F. Applications 1. Refrigerators 2. Air Conditioners	Lecture and demonstration.	
G. Installation		Students will learn how to install and service absorption systems.
H. Service Problems 1. Too little cooling 2. Too much cooling 3. Other	Lecture and demonstration.	

INSTRUCTIONAL AIDS

FOR

BLOCK 15

1. Books:

Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning. Goodheart and Willcox Company, 18250 Harwood Avenue, Homewood, Illinois 60430.
Chapter 17.

2. Visual Aids:

Charts
Films

Block 16 TITLE AUTOMOBILE AIR CONDITIONING Hours 70

Units of Instruction	Information/Methodology	Skill-Development Activities
A. Introduction	Lecture and discussion.	Students will learn how to work safely with air conditioning systems.
B. Safety		
C. Principles of Operation	Lecture, demonstration and discussion.	
D. Operating Conditions 1. Hot 2. Damp 3. Foggy 4. Dust and Smoke		
E. Types of Systems 1. Pressure operated low side pressure regulators. 2. Pressure operated bypass. 3. Solenoid operated bypass. 4. Electromagnetic clutch. 5. Combinations of the above.	Lecture, demonstration and discussion.	Students will be able to identify different types of systems and controls.
F. Types of Controls 1. Expansion valves 2. Suction pressure valves 3. Bypass valves 4. Service valves		

Block 16 TITLE AUTOMOBILE AIR CONDITIONING (Continued) Hours 70

Units of Instruction	Information/Methodology	Skill-Development Activities
G. Operating Pressures	Lecture and demonstration.	Students will learn to determine operating pressures.
H. Installation	Lecture and demonstration.	Students will learn how to install and service auto air conditioners.
I. Servicing	Lecture and demonstration.	

INSTRUCTIONAL AIDS

FOR

BLOCK 16

1. Books:

Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning. Goodheart and Willcox Company, 18250 Harwood Avenue, Homewood, Illinois 60430.
Chapter 25.

2. Visual Aids:

Charts
Films
Free literature from automobile air conditioner manufacturers

Block 17 TITLE HEAT PUMPS Hours 40

Units of Instruction	Information/Methodology	Skill-Development Activities
A. Introduction	Lecture and discussion.	Students will use heat pump demonstrators to show principle of operation of heat pump.
B. Safety		
C. Principles of Operation	Lecture, demonstration and discussion.	
D. Component Parts 1. Compressor 2. Condenser 3. Receiver 4. Liquid Line 5. Refrigerant Control 6. Evaporator Coil 7. Suction Line 8. Motor Control		Students will be able to identify the components of heat pump system.
E. Condenser and Evaporator Coils 1. Air Coil 2. Water Coil 3. Ground Coil	Lecture, demonstration and discussion.	
F. Air to Air System		Students will become familiar with the different kinds of systems.
G. Water to Air System		

Block 17 TITLE HEAT PUMPS (Continued) Hours 40

Units of Instruction	Information/Methodology	Skill-Development Activities
H. Earth to Air System I. Defrost System J. Control System K. Installation L. Servicing	Lecture, demonstration and discussion.	Students will learn how to install and service heat pumps.

INSTRUCTIONAL AIDS

FOR

BLOCK 17

1. Books:

   Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning. Goodheart and Willcox Company, 18250 Harwood Avenue, Homewood, Illinois 60430.
   Chapter 26.

2. Student Trainers

3. Visual Aids:

   Films
   Charts

Block 18 TITLE HEATING SYSTEMS Hours 150

Units of Instruction	Information/Methodology	Skill-Development Activities
A. Introduction	Lecture and discussion.	Students will demonstrate correct safety practices.
B. Safety		
C. Types of Heating Systems 1. Oil - Hot Water 2. Oil - Forced Air 3. Gas - Hot Water 4. Gas - Forced Air 5. Electric Baseboard 6. Electric - Forced Air 7. Coal - Hot Water 8. Coal - Forced Air 9. Wood - Hot Air 10. Wood - Hot Air or Gravity Hot Air	Lecture, demonstration and discussion. Demonstrate with charts and pictures of the different types of heating systems.	Students will work with different types of heating systems
D. Terminology and Operating Principles 1. British Thermal Unit (BTU) 2. Heat principles 3. Temperature measurements 4. Combustion a. Combustion testing b. Chimneys c. Draft d. Combustion troubles e. Combustion noise	Operating principles and terminology will be explained. Lecture and discussion.	Students will apply principles and terminology when working with heating system equipment, materials and literature.

Block 18 TITLE HEATING SYSTEMS (Continued) Hours 150

Units of Instruction	Information/Methodology	Skill-Development Activities
E. Heating and Oil Burner Maintenance	Maintenance procedures and practices will be demonstrated by the use of lecture and demonstration with graphic aids.	Students will be able to perform maintenance and install certain heating systems.
F. Types of Fuel		Students will be able to identify different types of fuels, boilers and furnaces.
G. Boilers		
H. Furnaces	Information on fuels, boilers and furnaces will be provided through lectures, demonstration and the use of visual aids.	
I. Oil Furnaces and Boilers 1. Mechanical Components a. Couplings b. Blowers c. Nozzles d. Fuel pumps e. Ignition systems f. Transformer g. Bus Bars	The name and function of the different parts will be explained and the parts will be demonstrated.	Students will be able to use and identify the different mechanical parts.

Block 18 TITLE HEATING SYSTEMS (Continued) Hours 150

Units of Instruction	Information/Methodology	Skill-Development Activities
I. Oil Furnaces and Boilers (continued) h. Ignition Transportation i. Electrode Assembly		
2. Electrical Components a. Wiring and Controls b. Thermostats c. Fan Controls d. Limit Controls e. Motors f. Relays g. Cadmium Cell	Electrical components will be explained and their use demonstrated.	Students will be able to identify and use these components.
3. Oil Storage a. Underground b. Above ground c. One line system d. Two line system e. Inside	Different types of storage systems will be demonstrated.	Students will be able to identify different types of oil storage systems.
4. Trouble-Shooting	Trouble-shooting procedures and techniques will be demonstrated.	Students will be able to trouble-shoot oil furnaces and boilers.

INSTRUCTIONAL AIDS

FOR

BLOCK 18

1. Books:

Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning. Goodheart and Willcox Company, 18250 Harwood Avenue, Homewood, Illinois 60430.

Field, Edwin M. Oil Burners, 1972. Theodore Audel & Co., a division of Howard W. Sams & Company, Inc., 4300 W. 62nd Street, Indianapolis, Indiana 46206.

2. Visual Aids:

Films
Charts
Furnaces, Boilers and Controls

3. Lennox Trainer

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APPENDIX A

Unit Guide Example, Block 5

DESCRIPTION OF THE UNIT GUIDE

The unit guide which follows will serve as an example of the preparation needed for teaching the various units of instruction. The teacher should develop unit guides for each block in the curriculum guide. In this sample guide lesson plans are included for selected lessons only. A completed unit guide should contain a lesson plan for each lesson title listed in the block breakdown. Each teacher should develop his/her own content. The lesson plans included here are intended to serve only as examples.

The approach for the unit guide is suggestive only and each teacher may elect to develop an individual format.

UNIT GUIDE

COURSE TITLE AIR CONDITIONING AND REFRIGERATION

BLOCK NO. 5 TITLE AIR CONDITIONING & REFRIGERATION FUNDAMENTALS

UNIT B TITLE BASIC THEORY OF REFRIGERATION

UNIT OBJECTIVES

(Example)

As a result of your teaching and student learning, your students will be able to: (state behavioral objectives)

1. Demonstrate safety principles and practices when working with air conditioning and refrigeration equipment.
2. Apply principles of heat transfer and the basic laws of air conditioning and refrigeration.
3. Make temperature measurements of circulated air using the Rankin and Kelvin scales.
4. Convert centigrade degrees to Fahrenheit degrees.
5. Measure the pressure in air ducts using a water manometer.
6. Interpret air pressure readings from the compound gauge.
7. Perform basic calculations used to determine specific air conditioning and refrigeration variables.
8. Determine relative humidity using a hygrometer.

UNIT 5 TITLES OF LESSONS

(Example)

UNIT TITLE: BASIC THEORY OF REFRIGERATION

Note: All references are taken from Modern Refrigeration and Air Conditioning, by Althouse, Turnquist and Bracciano.

No.	Doing Lessons	Ref. Code	No.	Knowing Lessons	Ref. Code
D5	How To:		K5	Technical Topics	
D5-1	Use safe work habits on the job.		K5-1	Safe work habits	p. 33
D5-2	Demonstrate principles of heat transfer.	p. 33	K5-2	Heat transfer methods	pp. 12-18
D5-3	Make temperature, pressure and humidity measurements.	pp.12 -18	K5-3	Temperature, pressure and humidity	
			K5-4	Power, force, specific gravity and BTU	pp. 22-23
D5-4	Calculate power, force, specific gravity and BTU.	pp.22 -23	K5-5	Gas laws	pp. 36-37
D5-5	Apply air conditioning and refrigeration principles.	pp. 9 -41		General Topics	
			6.	Relative humidity	p. 39, 781
			7.	BTU	p. 23
			8.	Ambient temperature	p. 775
			9.	Specific gravity	p. 22
			10.	Work and energy	p. 23, 1019
			11.	Power	p. 23
				Guidance Topics	
			12.	Employment opportunities	p. 571
			13.	Consumer applications of air conditioning and refrigeration.	p. 537
			14.	Importance of air conditioning and refrigeration today.	p. 387, 571

TEACHING EXPEDIENTS

(Example)

1. Books:

Zbar, Paul B. Basic Electricity, McGraw-Hill Book Company, Box 404, Hightstown, New Jersey 08520.

Oldfield, R. L. Practical Dictionary of Electricity and Electronics, American Technical Society, 848 E. 58th Street, Chicago, Illinois 60637.

Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning. Goodheart and Willcox, 18250 Harwood Avenue, Homewood, Illinois 60430.

2. Project Activity Materials

Student trainers

3. Demonstration Equipment

Heat transfer units
Convectors
Radiators
Conductors

4. Other Materials - Equipment

Overhead projector
16 mm motion picture projector
*Transparencies:

5. Resource Persons

Industrial personnel employed in air conditioning and refrigeration plants

A021 Principles of Refrigeration (set 24) $46.80
A094 Air Distribution and Duct Design (set - 3) $ 5.85
A057 Motors and Controls (set - 16) $31.20

Films:

Air of Good Living, Tappan Air Conditioning Division, Advertising Department, 206 Woodford Avenue, Elyria, Ohio 44035.

Temperatures Made to Order. Harrison Radiator Division, General Motors Corporation, Public Relations Staff-Film Library, General Motors Building, Detroit, Michigan 48202.

*May be purchased from United Transparencies, Inc., P.O. Box 688, Binghamton, New York 13902.

SUGGESTED METHOD OF APPROACH

(Example)

The following method of approach for this course unit is suggestive only. However, if you have had little experience in teaching the content of this unit, it is advisable that you follow the approach in detail for your first teaching. As you gain experience, new ways to demonstrate and make information topics dynamic will come to you and these should be recorded in the spaces between the steps in the teaching approach. The teaching approach below will run from the first to the last day of the unit. You will have to decide how much to cover each day the class meets.

SUGGESTED TEACHER APPROACH	STUDENT ACTIVITY
1. Introduction A. Check attendance. B. Explain shop practices and procedures. C. Introduce subject.	1. Class Assembly A. Discussion, question and answer period. B. Secure materials and fill out necessary forms.
2. Safe Work Habits K5-1 A. Lecture on safety in the shop. B. Show film on Shop Safety.	2. Activity A. Discussion and questions on shop safety. B. Observe film and discuss safety principles. C. Learn emergency exits and equipment and become familiar with operation and use. D. Become familiar with fire drill procedures and routes of entrance and exit.
3. Basic A/C and Refrigeration Terms K5-2 Discuss and show application of terms.	3. Activity A. Define terms and discuss their meaning. B. Relate terms to A/C and Refrigeration systems.
4. Refrigeration and A/C Principles A. Explain basic A/C and refrigeration principles. B. Demonstrate the application of these principles. C. Discuss types of A/C and refrigeration units utilizing the principles. D. Show the application of these types of A/C and refrigeration units.	4. Class Assembly A. Discuss A/C and refrigeration principles; raise questions. B. Observe demonstration. Perform lab practice using student demonstration unit. C. Observe pictures of and practice with actual A/C and refrigeration units. D. Observe the different types of units and where they are used.

SUGGESTED TEACHER APPROACH	STUDENT ACTIVITY
5. Heat Transfer Methods A. Identify the three methods of heat transfer. 1. Radiation 2. Conduction 3. Convection B. Explain the principle used by each method to transfer heat. C. Show examples of heating devices making use of these three methods of heat transfer. D. Explain and demonstrate how to install and service these heating devices.	5. Class Assembly A. Take notes, raise questions and discuss heat transfer methods. B. Observe and be able to state the principles used by each heat transfer method. C. Observe and be able to identify these devices. Raise questions. D. Observe demonstration and practice installing and testing heating devices.
6. Laws of Gases and Pressure A. Identify and explain the laws dealing with gases. B. Show the application of these laws to the equipment utilizing them. C. Explain the mathematical calculation of these laws. D. Boyle's Law $P_o \times V_o = P_n \times V_n$ E. Charles' Law $P_o \times T_n = P_n \times T_o$ $V_o T_n = V_n \times T_o$ F. The combination of Charles' Law and Boyle's Law. $\frac{P_o \times V_o}{T_o} = \frac{P_n \times V_n}{T_n}$	6. Class Assembly A. Observe lesson explanation and demonstration. B. Use student trainers to demonstrate the application of principles of gas laws. C. Perform mathematical calculations of pressure, volume and temperature, using gas law equations.

SUGGESTED METHOD OF APPROACH

(Continued)

SUGGESTED TEACHER APPROACH	STUDENT ACTIVITY
6. Laws of Gases and Pressure (Continued) G. Dalton's Law Total pressure of a combined mixture - sum of pressure of each gas in the mixture.	
7. Temperature and Pressure A. Definition of temperature. B. Explain temperature measurement. C. Discuss temperature scales. 1. Fahrenheit 2. Centigrade 3. Celsius D. Explain the use of absolute temperature scales. 1. Rankin scale 2. Kelvin scale E. Explain and demonstrate the use of temperature conversion equations. 1. $F = (\frac{9}{5} \times C) + 32$ $F = (\frac{180}{100} \times C) + 32$ 2. $C = \frac{100}{180} \times (F - 32)$ $C = \frac{5}{9} \times (F - 32)$ F. Define pressure and explain how it is measured. G. Explain and demonstrate the effect of pressure on temperature.	7. Class Assembly A. Observe class lectures and demonstrations and participate in class discussions. B. Take temperature measurements and read temperature scales. C. Use student trainers to help understand temperature and pressure measurements. D. Perform temperature conversions using mathematical equations.

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SUGGESTED METHOD OF APPROACH

(Continued)

SUGGESTED TEACHER APPROACH	STUDENT ACTIVITY
8. Humidity A. Explain the meaning of humidity. B. Explain and demonstrate how humidity is measured. C. Discuss how humidity can be increased or decreased.	8. Class Assembly A. Participate in class discussion. B. Use demonstration units to demonstrate humidity and its measurement and control. C. Observe films, charts, pictures and other materials that discuss humidity.
9. Testing A. Administer test. B. Return graded tests and discuss.	9. A. Take test. B. Discuss test.

INSTRUCTOR'S LESSON PLAN
Related Technical Information

(Example)

LESSON TITLE: HEAT TRANSFER SYSTEMS

Block 5
Unit B
Lesson K5-2

AIM: To explain the principle of heat transfer.

TEACHING AIDS: Transparencies, films, books, charts and handouts.

REFERENCES: Althouse, Turnquist, Bracciano. Modern Refrigeration and Air Conditioning.

I. PREPARATION (of the learner)

A. When heat is transferred from one medium to another or from one place to another, the place from which the heat was removed is cooler than before. Also, the place to which the heat was transferred is hotter.

B. Certain materials will dissipate heat more readily than others. Therefore, some materials are better conductors of heat than others.

II. PRESENTATION (of the information)

Instructional Topics	Key Points (things to remember to do or say)
A. The radiator as a heat transfer device.	A. 1. Construction is usually cast iron. 2. Hot water or steam heats the radiator. 3. Radiator gives off heat to surrounding air. 4. Valves on radiator control rate of flow of steam or water.
B. The convector is a heat transfer device used in a refrigeration system.	B. 1. Construction is usually of aluminum alloy or other light weight material permitting rapid dissipation of heat. 2. Heat generated by compressing the gas vapor within a refrigeration system, is dissipated by the convector, to the surrounding air, thereby converting the vapor back to liquid freon.

INSTRUCTOR'S LESSON PLAN

(Continued)

II. PRESENTATION (of the information) (Continued)

Instructional Topics	Key Points (things to remember to do or say)
C. Air handling unit.	C. 1. The unit in which the heating radiator and cooling convectors are installed to control the temperature of the air passing through it. 2. Air temperature can be controlled by dampers in the ducts or by opening and closing registers located in the rooms.
D. Effect of cleanliness on efficiency of operation.	D. Periodic cleaning of filters, coils and other surfaces that may restrict air flow or cause heat build-up.
E. Summary.	
F. Answer any remaining questions.	

III. APPLICATION

A. Students will sketch diagrams of different type systems, showing water or steam flow and heat dissipation pattern.

B. Students will give oral explanation of principle of operation of the three systems.

IV. CHECK UP (or test)

Test on Heat Transfer Systems

Suggested Reading for Student: Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning.

The Next Lesson Is: Heat Transfer Systems

INSTRUCTOR'S LESSON PLAN
Manipulative Skills

(Example)

LESSON TITLE: HEAT TRANSFER SYSTEMS

Block 5
Unit B
Lesson D5-2

AIM: Students will observe and test the operation of heat transfer systems.

TOOLS AND EQUIPMENT: Thermometer; heat transfer systems.

REFERENCES: Althouse, Turnquist, Bracciano. Modern Refrigeration and Air Conditioning.

I. PREPARATION (of the learner)

A. In order for air conditioning and heating systems to function, heat must be transferred from one place to another.

B. There are three basic methods by which heat may be transferred: Radiation, conduction and convection.

II. PRESENTATION (of the skills)

Steps	Key Points (things to remember to do or say)
Observation	Note: 1. Measure and compare air temperature before and after cleaning system. 2. Anything that obstructs air flow alters the efficiency of operation of the system.
A. Observe the effect of dirty and clean condenser coils on operation of the system.	A. 1. Clean condenser coils regularly. 2. Move any obstructions that would prevent free flow of air across coils.
B. Observe the effect of dirty and clean filter on operation of system.	B. Change filter regularly.
C. Observe the effect on air temperature of opening and closing the dampers in the forced air system.	C. 1. Closing damper restricts air flow and raises room temperature. 2. Opening damper permits free flow of air and lowers room temperature.

INSTRUCTOR'S LESSON PLAN

(Continued)

II. PRESENTATION (of the skills)
(Continued)

Steps	Key Points (things to remember to do or say)
Class discussion and question and answer period.	D. Discuss making temperature measurements and adjusting damper.
Explain cleaning of system.	E. Show how to clean coils and replace filters.

III. APPLICATION (practice by learner under close supervision)

Students will work in groups of two, making temperature measurements, cleaning coils, replacing filters, adjusting dampers (if desirable) and observing operation of system.

IV. CHECKUP (or test performance of skill to acceptable standards)

Test each student on individual performance and knowledge.

The Next Lesson Is: Basic Laws: Boyle's Law, Charles' Law, and Dalton's Law.

UNIT TEST

(Example)

COURSE: _____ Date: _____

INSTRUCTOR: _____ School: _____

SUBJECT: _____ Score: _____

Multiple Choice:

Directions: In the following questions or statements, place the letter of the correct answer, in the blank space to the left.

Example: When heat is transferred from the sun to the earth, the process of heat transfer is called:

_____ A. Conduction
__B__ B. Radiation
_____ C. Condition
_____ D. Convection

1. The forced air system uses which of the following heat transfer methods?

_____ A. Conduction
_____ B. Convection
_____ C. Radiation
_____ D. Radiation and Conduction

2. The efficiency of a heat transfer system is:

_____ A. Improved by closing the dampers.
_____ B. Reduced by cleaning the coils.
_____ C. Increased by using a clean filter.
_____ D. Not affected by cleaning the coils.

3. Convection can be aided by:

_____ A. Decreasing fan motor speed.
_____ B. Increasing speed of air.
_____ C. Decreasing speed of air.
_____ D. Decreasing the size of ducts.

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UNIT TEST

(Continued)

Matching Items:

Directions: Match the terms in the right-hand column to the definitions in the left-hand column by placing the letter of the correct matching answer, in the blank spaces at the left.

_____ 1.	The moving of heat from one place to another by heating a substance.	A.	Conduction
_____ 2.	The flow of heat from one part of a substance to another part of that same substance.	B.	Critical Temperature
_____ 3.	The maximum temperature at which a material may be liquefied, regardless of the pressure applied to it.	C.	Radiation
_____ 4.	The process whereby some substances are heated by the absorption of heat rays given off by another source.	D.	Convection
_____ 5.	The pressure at which a substance will remain a liquid.		

PROBLEMS

1. Using Boyle's Law, determine the new volume of 5 cubic feet of gas at 20 psig if it is compressed to 60 psig, providing the temperature remains constant. The atmospheric pressure is 15 psi.

2. Using Charles' Law, determine the new volume of 5 cubic feet of gas at 37° F if it rose to 90° F at constant pressure.

APPENDIX B

SAFETY PRECAUTIONS

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GENERAL SAFETY PRECAUTIONS

1. Never engage in "horse play" in the shop or on the job.
2. Wear safety glasses when operating rotating machinery, soldering, hammering, or working with line voltage.
3. Always use the right tool for the job to be performed.
4. Keep tools and equipment in good condition.
5. Report all hazardous conditions.
6. Never leave tools or materials on anything higher than your head.
7. Before starting a machine, check that it is in a condition to move freely and that keys or wrenches are removed.
8. Think a job through before starting to work.
9. Report all injuries to instructor, no matter how slight.
10. If you are not absolutely sure that a situation is safe, ask for assistance.
11. Line (power) voltages can kill and should not be contacted with the hands or body.
12. Do not use live cords if the insulation is brittle or crushed.
13. Shut off power before connecting test instruments to a live circuit.
14. Do not defeat the safety feature of polarized 3-post plugs by using ungrounded adapters.
15. Do not defeat any safety device, such as a fuse or circuit-breaker by short circuiting across it, or by using a higher amperage fuse than specified.
16. When using power tools, secure your work in a vise or jig.
17. Measure voltages with one hand in your pocket or against your side.
18. When necessary to approach someone operating a machine or working near live wires, do so in such a manner as not to annoy or alarm.
19. Under all conditions stop, look and think before you proceed in a dangerous situation.
20. Exercise good judgment and common sense and your life in the shop will be safe, interesting and rewarding.

SHOP RULES FOR THE UNIT

Note: All instructors should develop their own safety curricula according to individual needs.

Examples:

1. Always wear safety glasses.
2. No "horse-play" at any time.
3. No "smoking."
4. No running.
5. "Housekeeping" (cannot be stressed too much).
6. Do not operate any machine until you have been instructed and tested.
7. Keep tools clean.
8. Do not throw tools or objects.
9. Stay in your shop (or lab) unless permission to leave has been granted by your instructor.
10. Do not use compressed air to clean clothes or skin.
11. Know your fire extinguisher locations.
12. Do not push any start or stop switches unless you have been instructed to do so.
13. Do not open or close any valves unless you have been instructed to do so.
14. Inspect your equipment before operating.
15. Wear clothing suitable for work being performed.
16. Disconnect main power source (lock-out and test) when making repairs or adjustments.
17. "Wipe up" any oil that is spilled on floor.
18. Do not wear sandals or tennis shoes.
19. Do not wear rings or wrist watches when working on equipment.
20. Do not show off your strength by lifting heavy objects.

SHOP RULES FOR THE UNIT

(Continued)

21. Hard hats are to be worn while performing construction or installation work.

22. If an injury occurs, notify instructor immediately (regardless of severity).

MEMO TO PARENTS

(Example)

Dear Parent:

Listed below are twenty safety rules, and your child has passed a test on these rules. Please sign to indicate that you have discussed this test with your child. Additional safety rules will be stressed for each piece of equipment. We want you to know that your child's safety is our first concern at Jackson River Vocational Center.

INSTRUCTOR _____

SAFETY RULES

1. Stay in your shop unless permission to leave has been granted by the instructor.
2. Do not throw tools or objects.
3. Do not use air drops (compressed air) to clean clothing or skin.
4. Do not push any start or stop switches unless you know what they control.
5. Do not open any valves unless you know what you are doing.
6. No "horse play" is permitted at any time.
7. Do not operate any machine until you have been instructed to do so.
8. Know your equipment before operating.
9. Keep tools clean.
10. If you have any questions concerning safety, go to your instructor. Don't wait until you are hurt.
11. No running in building.
12. Wear safety glasses: (1) as dictated by your instructor; (2) when striking metal to metal (i.e., hammer to nail); and (3) when your eyes are in danger.
13. Know your fire extinguisher location, and how and when to use it.
14. Wear shoes suitable for work being performed.
15. Never wear loose clothing aroung moving machinery (for example - neckties, sleeves, long hair, etc.).
16. Disconnect main power source (lock-out and test) when making repairs or adjustments.

SHOP RULES FOR THE UNIT

(Continued)

21. Hard hats are to be worn while performing construction or installation work.

22. If an injury occurs, notify instructor immediately (regardless of severity).

MEMO TO PARENTS

(Example)

Dear Parent:

Listed below are twenty safety rules, and your child has passed a test on these rules. Please sign to indicate that you have discussed this test with your child. Additional safety rules will be stressed for each piece of equipment. We want you to know that your child's safety is our first concern at Jackson River Vocational Center.

INSTRUCTOR _____

SAFETY RULES

1. Stay in your shop unless permission to leave has been granted by the instructor.
2. Do not throw tools or objects.
3. Do not usé air drops (compressed air) to clean clothing or skin.
4. Do not push any start or stop switches unless you know what they control.
5. Do not open any valves unless you know what you are doing.
6. No "horse play" is permitted at any time.
7. Do not operate any machine until you have been instructed to do so.
8. Know your equipment before operating.
9. Keep tools clean.
10. If you have any questions concerning safety, go to your instructor. Don't wait until you are hurt.
11. No running in building.
12. Wear safety glasses: (1) as dictated by your instructor; (2) when striking metal to metal (i.e., hammer to nail); and (3) when your eyes are in danger.
13. Know your fire extinguisher location, and how and when to use it.
14. Wear shoes suitable for work being performed.
15. Never wear loose clothing aroung moving machinery (for example - neckties, sleeves, long hair, etc.).
16. Disconnect main power source (lock-out and test) when making repairs or adjustments.

SAFETY RULES

(Continued)

17. No rings or watches are allowed while working.

18. All guards must be in place before using a machine.

19. Keep all areas clean and safe.

20. Be alert --- Think Safety.

PARENT'S SIGNATURE_____

SHOP SAFETY EQUIPMENT AND CONDITIONS

1. Fire extinguishers
2. Safety glasses w/side shields
3. Self-closing oily rag containers
4. Hard hats
5. Safety lines (painted on floor)
6. Electrical safety switches (touch type)
7. Sufficient lighting
8. Sufficient ventilation
9. Hazardous area warning signs
10. First aid kit
11. Eye-wash station
12. Safety guards on belts, fans, etc.

APPENDIX C

SHOP MANAGEMENT

PERSONNEL DUTIES

(Example)

In this section are examples of materials which are aids to student management. Each instructor is encouraged to develop a student management system. Below is a suggested list of offices, with the duties included.

I. SUPERINTENDENT DUTIES

Has full responsibility over the class.
All other students and officers report to superintendent in case of any problems.
Dismisses the class after determining that the shop is left in proper order.
Moves about the shop, during class, observing all activities, and attempting to eliminate any situation which may endanger students or equipment.
Reports to the instructor as required.

II. TOOLROOM SUPERVISOR DUTIES

Is responsible for checking out and checking in all tools that are used by students.
Sees that all tools are in good condition and clean, prior to checking out and checking in.
Reports all damaged or missing tools to class superintendent.
Opens the toolroom at the beginning of class and closes it at the end of the period.

III. RECORD CLERK DUTIES

Takes the roll, assists the teacher in correcting certain technical quiz papers and performs other clerical duties as assigned by the instructor.

IV. MAINTENANCE SUPERVISOR DUTIES

Is responsible for the maintenance and repair of shop tools and equipment. These duties may vary at the discretion of the teacher.

V. CLEAN-UP SUPERVISOR DUTIES

Checks that students clean up their own work areas and maintain the entire shop in a clean condition.

PERSONNEL DUTIES

(Continued)

VI. SAFETY SUPERVISOR DUTIES

Responsible for checking the shop for unsafe conditions, and for reporting any unsafe situations to the instructor.
Checks that fire extinguishers are in their correct places.
Checks that first-aid kit is in the designated place and is stocked properly.
Insures that safety information is displayed properly.

Note: The teacher may alter any of these offices and duties as desired.

STUDENT ASSIGNMENT FORM

NAME OF STUDENT										
ASSIGNMENT	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE
SUPERINTENDENT										
TOOLROOM FOREMAN										
RECORD CLERK										
MAINTENANCE FOREMAN										
CLEAN-UP FOREMAN										
SAFETY FOREMAN										

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TOOL CHECK-OUT FORM

NAME OF TOOL											STUDENT'S SIGNATURE
STUDENT'S NAME	DATE		DATE		DATE		DATE		DATE		
	Out	In	Out	In	Out	In	Out	In	Out	In	

SAFETY REPORT
UNSAFE PRACTICE REPORT FORM _____

UNSAFE ACT COMMITTED										
NAME	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE
1.										
2.										
3.										
4.										
5.										
6.										
7.										
8.										

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LOCKER ASSIGNMENT SHEET

STUDENT'S NAME	LOCKER NUMBERS											
	1	2	3	4	5	6	7	8	9	10	11	12

PROGRESS CHART

NAMES	JOB NO.															
	JOBS															

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APPENDIX D

ADDITIONAL REFERENCES AND VISUAL AIDS

REFERENCES AND VISUAL AIDS

BOOKS:

Althouse, Turnquist and Bracciano. Modern Refrigeration and Air Conditioning, Goodheart and Willcox Company, 18250 Harwood Avenue, Homewood, Illinois 60430.

Oldfield, R. L. The Practical Dictionary of Electricity and Electronics, American Technical Society, 848 East 58th Street, Chicago, Illinois 60637.

Zbar, Paul B. Basic Electricity, McGraw-Hill Book Company, Box 404 Hightstown, New Jersey 08520.

TRANSPARENCIES:

The following transparencies may be purchased from United Transparencies, Inc., P. O. Box 688, Binghamton, New York 13902.

A002 Basic Physical Theory (set - 9)

A012 Electricity (set - 6)

A021 Principles of Refrigeration (set - 24)

A057 Motors and Controls (set - 16)

A094 Air Distribution and Duct Design (set - 3)

REFERENCES AND VISUAL AIDS

(Continued)

FILMS:

The following films are available from the U. S. Navy Film Library, U. S. Naval Base, Education & Training Detachment, Building W-313, Naval Station, Norfolk, VA. 23511 - Attention: Public Affairs Officer.

1. Amperes, Volts and Ohms. MN 1540-u 10 min. B/W.
2. Basic D. C. Meter Movement. MN 8019-e 10 min. B/W.
3. Basic Electricity: A.C. Parallel. MN 8019-D 14 min. B/W.
4. Basic Electricity A.C. Series. MN 8018-c 15 min. B/W.
5. Current Flow - What It Is. MN 8016-c 4 min. B/W.
6. Series and Parallel Circuits. MN 1540-v 17 min. B/W.
7. VOM Operation. MN 1540-a

The following films can be ordered from Handel Film Corporation, 6926 Melrose Avenue, Hollywood, California 19638. They were produced for the General Electric Company, 60 Washington Avenue, Schenectady, New York 12345.

1. Magnetism at Work. 11 min. Color.
2. Principles of Electricity. 20 min. Color.

The following films can be ordered from Bureau of Teaching Materials, Virginia Department of Education, Richmond, Virginia 23216

1. Federal Taxation
2. Finding Your Life Work
3. I Want A Job
4. Introducing The New Worker To His Job
5. Supervising Workers On The Job
6. Are You A Good Citizen?
7. Are You Popular?
8. Control Your Emotions.

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9. Developing Friendship

10. Developing Leadership

11. Improve Your Personality

12. Developing Self Reliance

The following films may be ordered from the National Audio-Visual Center, The Archives, Washington, D.C. 20409.

1. Adding and/or Removing a Refrigerant, Order No. OE441.

2. Adjusting and Checking the Expansion Valve, Order No. OE444.

3. Adjusting and Repairing the Thermo Expansion Valve, Order No. OE448.

4. Basic Electricity, Order No. AF 213-2.

5. Checking the System, Part I, Order No. OE438.

6. Checking the System, Part II, Order No. OE439.

7. Hand Soldering, Order No. OE479.

8. Making and Repairing Tubing Connections, Order No. OE452.

9. Measuring Pipe, Tubing & Fittings, Order No. OE105.

10. Ohm's Law, Order No. TF11-1200.

11. Principles of Refrigeration, Order No. OE360.

12. Split Phase Motors, Order No. OE386.

13. What Causes Current Flow, Order No. MN8016-F

14. What Controls Current Flow, Order No. MN8016-G

15. Wire Sizes and Voltage Drop, Order No. OE372.

Magazines:

Refrigeration Service and Contracting, 2720 Des Plaines Avenue, Des Plaines, Illinois 60018.

NOTE: Many manufacturers offer free pamphlets and training aids on the pages of this magazine.

REFERENCES AND VISUAL AIDS

(Continued)

Materials, Folders, Charts:

Copeland Corporation, Sidney, Ohio 45365.

The Singer Company (Control Division), Schiller Park, Illinois 60176.

Frigidaire, Dupont and other large industrial concerns.

Visual Aids, Films and Filmstrips are available from the Air-Conditioning and Refrigeration Institute, 1815 North Fort Myer Drive, Arlington, Virginia 22209.